(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 March 2001 (15.03.2001)

PCT

(10) International Publication Number
WO 01/18658 A1

(51) International Patent Classification[7]: G06F 13/00

(21) International Application Number: PCT/US00/40593

(22) International Filing Date: 7 August 2000 (07.08.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/390,599 3 September 1999 (03.09.1999) US

(71) Applicant: HOTV INC. [US/US]; Suite 350, 11455 El Camino Real, San Diego, CA 92130 (US).

(72) Inventors: SHASTRI, Vijnan; 12664 Torrey Bluff Drive #216, San Diego, CA 92130 (US). ARYA, Ashwani; 12664 Torrey Bluff Drive #216, San Diego, CA 92130 (US). GUPTA, Parul; 12670 Torrey Bluff Drive #267, San Diego, CA 92130 (US).

(74) Agent: BOYS, Donald, R.; P.O. Box 187, Aromas, CA 95004 (US).

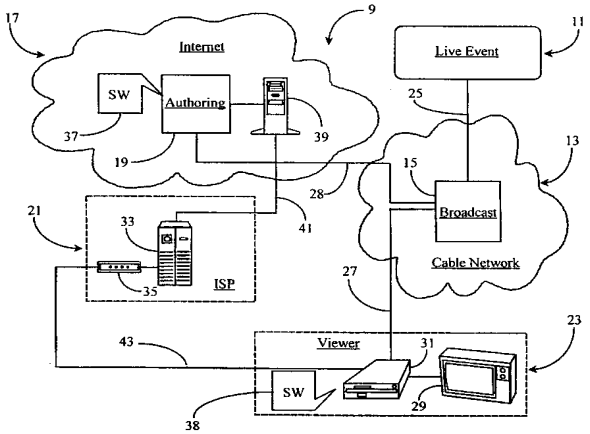
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND APPARATUS FOR SENDING SLOW MOTION VIDEO-CLIPS FROM VIDEO PRESENTATIONS TO END VIEWERS UPON REQUEST



(57) Abstract: A video system (9) includes a software-enabled, Internet-connected server (39) storing video clips of action scenes from a primary video presentation (11) and an Internet-connected client computerized viewer station (23) having a video display unit (VDU) (29) and an interactive user interface. The server provides displayable indicia uniquely representing individual video clips stored at the server to the client as displayable hyperlinks, and in response to the client selecting one of the displayable indicia, the server streams the associated video clip to the client at a bit rate less than the real-time video rate, such that the video clip displayed at the client's station plays at a slow-motion rate. The less than real-time rate reduces data loss and therefore improves frame quality. By reducing the streaming rate for such clips significantly the quality is significantly improved, and for such as sports events the streamed clips may be displayed directly as slow-motion clips. Further, such clips may then be stored and speeded up providing real-time rate video replays at much-improved quality over such clips streamed on the Internet at real-time rates.

WO 01/18658 A1

Method and Apparatus for Sending Slow Motion Video-Clips from Video Presentations to End Viewers Upon Request

Field of the Invention

The present invention is in the field of interactive video, and pertains more particularly to methods and apparatus for editing live video steams and sending selected video clips to end viewers.

Background of the Invention

With continuing development of new and better ways of delivering television and other video presentations to end users coupled with parallel development of computerized information systems such as the Internet, there have been concerted efforts to integrate various systems to provide enhanced information delivery and entertainment systems. For example, developers are introducing integrated systems combining TVs with computer subsystems, so a TV may be used as a WEB browser, or a PC may be used for enhanced TV viewing.

In some systems, computer elements such as a CPU, memory, and the like, are built into the familiar chassis of a TV set. In such a system, the TV screen becomes the display monitor in the computer mode. In such a system, conventional TV elements and circuitry are incorporated along with the computer elements, and capability is provided for a user to switch modes, or to view recorded or broadcast video with added computer interaction. One may thus, with a properly equipped system, select to view analog TV programs, digital TV programs, conventional cable TV, satellite TV, pay TV from various sources, and browse the WWW as well, displaying WEB pages and interacting with on-screen fields and relational systems for jumping to related information, databases, and other WEB pages. The capabilities are often integrated into a single display, that is, one may view a broadcast presentation and also have a window on the display for WEB interaction.

In some other systems, computer elements are provided in an enclosure separate from the TV, often referred to in the art as a set-top box. Set-top box systems have an advantage for providers in that they may be connected to conventional television sets, so end users don't have to buy a new TV along with the computer elements.

In such integrated systems, whether in a single enclosure or as set-top box systems, user input is typically through a hand-held device quite similar to a familiar remote controller, usually having infra-red communication with the set-top box or a receiver in the integrated TV. For computer modes, such as WEB browsing, a cursor is displayed on the TV screen, and cursor manipulation is provided by buttons or other familiar pointer apparatus on the remote. Select buttons are also provided in the remote to perform the familiar function of such buttons on a pointer device, like a mouse or trackball more familiar to computer users.

Set-top boxes and computer-integrated TVs adapted as described above typically have inputs for such as a TV antenna (analog), cable TV (analog or digital), more recently direct-satellite TV (digital), and may also connect to video cassette recorders and to mass storage devices such as hard disk drives and CD-ROM drives to provide a capability for uploading video data from such devices and presenting the dynamic result as a display on the TV screen.

The present inventors have noted that with the coupling of computer technology with TV, many capabilities familiar to computer users have been made available to TV users. For example, ability to provide text annotation for TV presentations is considerably enhanced. Computer techniques such a Pix-on-Pix are now available, wherein separate TV presentations may be made in separate windows, or overlaid windows on the display screen. Separate windows may also support display from separate sources, such as an analog TV program in one window, a computer game in another, and a video conference in a third.

In typical prior art video authoring systems, end users receive a single video stream that contains the video data and any added annotated data such as subtitling, sponsor logos, information blocks, and the like. In analog video such annotation may be included as data in such as the video blanking intervals of the stream. In digital video the annotated stream may be integrated with the primary stream. However, it is desirable to the present inventors to

build upon the goal stated above, by having separate streams, one containing video data, and the other containing annotative data, that may arrive at an end user's location by the same medium or by a different medium such that the content defined by the separate streams may be displayed synchronously on a suitable display screen.

In a system known to the inventors, hyper-video authoring is possible wherein a wide variety of added, often interactive, content is made available to viewers having an active connection, such as cable or satellite to a content video provider and also an Internet connection for facilitating interactivity with a provider by virtue of the backlink provided. The system known to the inventors uses separate authoring stations or systems for use in what is termed hyper-video authoring by the inventors. Hyper-video authoring includes providing hot spots (interactive hyperlinks) in a video presentation, providing interactive regions for tracked objects (method known to the inventors), inserting URL's for user interaction, providing interactive banner ads, providing interactive icons for launching instant replays of short video clips, adding audio/text annotation, and so on.

Annotated content may, in some instances, be delivered via alternative paths, such as the Internet, and be synchronized with a main video stream being viewed at the user's end. In other instances, added content is combined at the provider end and delivered as one stream (typically cable or digital feed) to the viewer. As a viewer interacts with provided content through hot spots, creating backlink signals to the provider, information at the provider end associated with the viewer's interaction is sent to the viewer and typically displayed on the same display containing the primary video presentation. In some cases users, if so equipped, may save and store Internet-delivered content to suitable data storage facilities at the user's premises. In other cases, such material may be saved and stored on-line at a server adapted for the purpose. In this case, a viewer may at a later time retrieve the material at his or her discretion. Again, these systems are not in the public domain, but systems developed by the inventors.

One of the capabilities of the authoring system, described above and known to the inventor, is an ability to edit live video feeds wherein identifying and copying

specific portions of the video is performed for the purpose of creating short video clips of sequences in the main video. In some embodiments the authoring system uses a scene-change-detection-technology (SCDT) in order to identify and isolate individual video sequences or clips. In these systems authored video clips are stored in an Internet server adapted for the purpose, and may be delivered to a viewer upon user interaction with, for example, an icon, thumbnail, or text block, that is sent and displayed on the viewers display. Such indicators are interactive in that when activated by a viewer the associated video clip is immediately delivered to the viewer over the Internet.

An advantage of the above system is that a user watching a video of, for example, a football game, can view replay sequences such as touchdown runs, over again by clicking on an interactive indicator thereby initiating immediate Internet delivery of the replay content. The streamed replay clip may be viewed simultaneously on the same display as the primary video in, for example, a separate window. There are, however, some disadvantages or limitations inherent to this state of the art capability.

One disadvantage is that video sequences obtained from the Internet cannot typically be streamed to a user at data rates that enable viewing at a comparable quality offered by cable or satellite systems' high dedicated bandwidth. For example, digital cable can deliver video at data rates in the range of more than 1 megabits per second to enable at least 30 FPS viewing, and the high dedicated bandwidth guarantees that very little, if any, data will be lost. This provides a high quality video presentation that the viewer sees on the display screen. Standard Internet services that must share bandwidth are at present unable to provide such high and dedicated bandwidth. Even with compression techniques and bandwidth reservation schemes, video quality received from the Internet is not comparable to the quality offered by such as cable or satellite systems. Real-time video, such as 30 frames per second, delivered over the Internet is subject to significant data loss affecting the video quality negatively.

Another disadvantage of the systems known to the inventor is that after viewing a video which is streamed from the Internet or similar data-packet network, a user may want to playback the stream in slow motion. The already poor frame quality will

provide an even poorer slow-motion clip. In multimedia transmission of data over the Internet, it is always desirable to conserve the shared bandwidth. Moreover, many interactive TV viewers, particularly related to sports presentations, desire to view replays at slow-motion rates that are much slower than real-time frame speeds. Therefore, what is clearly needed is a method and apparatus that will enable an Internet server to stream slow-motion versions of requested video sequences to an end viewer who may view such slow-motion sequences with excellent quality on an interactive television device, including a PC enabled to display video, with an option of speeding the sequence up after download. Such a method and apparatus would conserve bandwidth, and allow high-quality slow motion viewing which may be speeded up at the viewers end (faster frame rate) resulting in even better quality.

Summary of the Invention

In a preferred embodiment of the present invention a slow-motion video replay system is provided, comprising a software-enabled, Internet-connected server storing video clips of action scenes selected from a primary video presentation; and an Internet-connected client computerized viewer station having a video display unit (VDU) and an interactive user interface. The server provides displayable indicia uniquely representing individual video clips stored at the server to the client as displayable hyperlinks, and in response to the client selecting one of the displayable indicia, streams the associated video clip to the client at a rate less than the real-time video rate, such that the video clip displayed at the client's station plays at a slow-motion rate.

The video clip streaming rate may vary considerably, but quality improvement is improved as streaming rate decreases to a point. In some embodiments an authoring station is coupled to both the server and to a service provider streaming the real-time primary video presentation to the client for display and also to the authoring station. The authoring station enables an author to create, select, and store video clips at the server, including associating the displayable indicia with the video clips.

In preferred embodiments the displayable indicia comprise text strings describing the associated video clip. Also in some embodiments the client station is enabled to store streamed slow-motion video clips, and the user is enabled through the interactive interface at the client station to retrieve and replay the stored clips, including adjusting the play rate from the streamed and stored rate. In still other embodiments the user is enabled to grab a selected frame from a video clip and to convert the frame to a standard still graphics format, including one or both of .gif and .jpg.

In another aspect of the invention a video authoring and server system is provided, comprising an authoring station including software enabling tools for an author to monitor a video presentation, to select video clips from the presentation for storage, and to prepare and associate an displayable indicia identifier with each video clip; and an Internet-connected server including software enabling pushing of the identifiers for video clips to clients as hyperlinks, and streaming of video clips to clients in response to signals from clients resulting from selecting the hyperlinks, the video clips streamed to clients on the Internet at a rate less than the real-time video rate.

In embodiments in this aspect of the invention the video clip streaming rate may vary widely, with quality improvement associated with lower streaming rate. In these embodiments and others the displayable indicia may comprise text strings describing the associated video clip.

In yet another aspect of the invention a client system for video display is provided, comprising a computerized video display apparatus; a high-bandwidth dedicated port for receiving a primary video stream; and an Internet port for requesting and receiving video clips of sequences selected from the primary video stream. The video display system displays a primary video stream received on the dedicated high-bandwidth port and interactive hyperlinks uniquely associated with individual ones of the video clips, the hyperlinks received on the Internet port, and wherein upon selection of a hyperlink the apparatus receives on the Internet port a secondary data stream for the video clip associated with the hyperlink, the secondary data stream received and displayed at a rate less than the real-time rate.

In this embodiment as in others, the video streaming rate for clips may vary widely, but higher quality is associated with generally lower streaming rate. As in other embodiments the hyperlinks may comprise text strings describing the associated video clip. Also in embodiments the computerized apparatus is enabled to store streamed slow-motion video clips, and the user is enabled to retrieve and replay the stored clips, including adjusting the play rate from the streamed and stored rate. Also in some embodiments the user is enabled to grab a selected frame from a video clip and to convert the frame to a standard still graphics format, including one or both of .gif and .jpg.

In another aspect of the invention a method for providing video clips over an Internet connection with high frame quality is provided, comprising steps of (a) receiving a request for a stored clip at an Internet-connected server; and (b) streaming the stored clip to the requester at a rate less than the real-time rate. The rate may vary widely, with quality generally improving with lower streaming rate. There may be a step for designating at an authoring station coupled to the server, the authoring station monitoring a primary video stream, sequences from the primary video stream as clips, and associating a unique identifier with each clip. The identifiers may comprise displayable indicia pushed to clients on the Internet as hyperlinks associated with stored clips, and the hyperlinks may be text strings describing the associated video clips.

In the embodiments of the invention, described in enabling detail below, for the first time a method and apparatus for providing high-quality video clips over an Internet connection is provided.

Brief Description of the Drawing Figures

Fig. 1 is an overview of a video authoring and delivery system according to an embodiment of the present invention.

Fig. 2A is an exemplary author interface at an authoring station shown in Fig. 1.

Fig. 2B is the authoring interface of Fig. 2A with an optional text window enabled.

Fig. 3 is a user interface display at an end-user station of Fig. 1 before a replay screen is presented.

Fig. 4 shows the user interface screen with a replay screen open playing a slow-motion replay while a main video continues to play in a separate window.

Fig. 5A is flow diagram illustrating steps in practicing one embodiment of the present invention wherein there is a relatively high bandwidth connection between a server and a client.

Fig. 5B is a flow diagram illustrating steps in practicing an embodiment of the present invention wherein there is a relatively low bandwidth connection between a server and a client.

Fig. 6 is a block diagram of an architecture for practicing the present invention in a preferred embodiment.

Description of the Preferred Embodiments

As was described in the background section, a system adapted for creating video clips from live video feeds and streaming them to end users on demand is already known to the inventors. However, the system known to the inventors streams the selected video clips at standard frame rates with full-speed motion. That is, at standard frame rates the events in the video clips play back at real-time speed. In a new system provided by the inventor and described herein, selected video clips are streamed over the Internet to users at a significantly reduced bit rate, providing two distinct advantages. The first is that the clip received by the end viewer may be played directly, providing a high-quality slow motion clip. The clip is high quality because there is significantly less data loss at the slower streaming rate, and because video quality is not compromised at encoding. The second is that, once a clip is downloaded at the reduced

bit rate, now the streamed clip may be speeded up at the viewers end, providing high-quality real-time viewing not possible with higher Internet streaming rates.

Fig. 1 is an overview of a video authoring and delivery system 9 according to an embodiment of the present invention. System 9 represents an exemplary service-system for authoring live video for the purpose of creating short slow-motion video clips that may be sent to a plurality of subscriber viewers over the Internet. System 9 comprises, basically, a cable network 13, an Internet network 17, an Internet Service Provider (ISP) 21, and a viewer premise 23.

A live event 11 is provided in this example as a suitable video source from the field. Event 11 may be any event such as a sporting event, a concert, or any event that viewers may subscribe to or obtain according to a published schedule, but the invention is most particularly applicable to sporting events for which viewers may be interested in slow-motion replay. Further, the invention is not limited to live broadcasts, but may be applied as well to stored video sent by any content provider.

A participating broadcast entity 15, hereinafter termed studio 15, is provided and adapted to receive a primary data stream from event 11, which is delivered as a raw feed to studio 15 by a digital cable 25. In some embodiments, delivery will be by satellite or other means. Studio 15 is adapted to serve video to end users, in this example to user premise 23 by means of cable connection 27. In other embodiments this primary video feed may be by satellite, or by any other high-bandwidth dedicated channel means.

By virtue of service pre-arrangement, presentations that are targeted for video authoring according to embodiments of the present invention are simultaneously cast to viewers and an authoring station. In this way, viewers may receive a primary video stream by one path, and annotated, often interactive content, including short video clips taken from the live event via an alternate path, in this example the Internet.

Premise 23 contains CPE equipment enabled to practice the present invention. A cable-ready television 29 is provided and adapted to display delivered content as is known in the art. In this example, a TV-connected set-top box 31 provides enhanced interactive capability to television 23. However, in some instances, television 23 may

contain the required circuitry and software enabling interactive TV. Set-top box 31 contains input ports for cable, satellite TV, and a port for connecting to the Internet. Set-top box 31 contains all of the required circuitry and software for enabling a subscriber interactive television service wherein one may watch TV and obtain interactive content associated with viewed programs, browse the Internet, and so on. In this example, a digital cable 27 provides cable connection for receiving video/Audio content delivered by studio 15 as is known in the art for cable services.

A software application 38 is provided and executable in set-top box 31. Application 38 consists of a software video player, communication and display routines for accepting and displaying content from, in this example, Internet 17. Software 38 also contains a means for notifying service-providing entities when a viewer is participating by viewing a service-covered event.

Studio 15 has a digital cable connection 28 to a video authoring station 19 located in Internet cloud 17. Authoring station 19 is adapted by virtue of computer and software capability to receive primary video content from studio 15 over cable 28. An instance of software (SW) 37 resident in station 19 provides a capability for editing and authoring video content that is received from studio 15. Such editing is in this example performed in real time, as the same video content is being transmitted to viewers. Among other editing capabilities that may be attributed to station 19, is the ability of identifying video sequences in main video content for the purpose of creating short video clips.

Authoring station 19 may comprise a single editing station or a plurality of linked editing stations (not shown) which may be automated to perform some editing functions, and manned by personnel (authors) for performing other editing functions. For the purposes of the present invention station 19 contains at least one manned computer enabled by software 37 to for selection of short video sequences taken from a main video stream. Video clips created by authoring station 19 are uploaded in this embodiment to a server 39 having an Internet connection 41.

At premise 23, an Internet connection 43 provides connection to Internet network 17 through an Internet service provider (ISP) 21 via standard modem protocol

(modem 35). Line 43 may be a single phone line or an integrated services digital network (ISDN) connection, for example. Other known connection methods to the Internet may also be used. An ISP server 33 is provided and has conventional service capability including access to server 39 that is accessible to authoring station 19 as previously described.

In practicing the present invention, video feeds such as representative feed 25 from event 11 are delivered to broadcast entity 15. Although a cable network 13 is used in this example, satellite networks may also apply. In some instances, more than one studio may be involved in editing a video feed. After editing a feed for broadcast/multicast to viewers, the stream is delivered to viewer 23, over such as a cable network represented by line 27. In the same time frame that the primary video feed is delivered to premise 23 by way of cable 27, it is also delivered to station 19 by way of cable 28.

An author at station 19, by virtue of software 37 and suitable computer equipment, selects sequences from the video presentation and creates short video clips. Typically in embodiments of the invention SCDT technology is used to isolate and select sequences from the primary video for production of the clips. During creation of a clip, all available frames of the main video are included in the created version. In this way optimum quality is maintained. Other annotation and editing functions known to the inventor may also be performed.

Created video clips represent such as instant replay material of events that have occurred in the main video. Touchdowns in football games, important baskets in basketball games, controversial plays, a knockout punch in boxing and the like, are representative of material that would be selected from the main video for producing clips. A time pipeline may provided for this process.

As video clips are created, they may be streamed directly to one or more end users, or streamed to server 39. They may also be annotated. The annotations become interactive text links that briefly describe an associated clip and may be sent to viewers. For example, in a preferred embodiment, as a clip enters server 39, an associated text

link is immediately delivered via push technology over the Internet to known and connected active viewers of the primary video to notify such viewers of clip availability.

Fig. 2A is an exemplary author interface at an authoring station shown in Fig. 1. In this interface a window 201 plays the primary video feed from which replays are selected. Control buttons 203 enable an author to select and review candidate sequences. As described above, in a preferred embodiment scene-detection software automatically selects scenes and, in one embodiment uses the first frame of a scene as a representative frame for the clip.

Field 205 lists the URL source for the primary video in this example. Field 207 allows the author to enter a filename for the clip selected. Field 209 allows the author to enter a URL address for the clip. Field 211 allows the author to enter a play rate for the clip when downloaded to a subscriber. In this case the play rate is .2, which indicates 1/5 of the real-time rate. If the real time rate is 30 frames per second, the streaming rate to the subscriber will be, in this case, 6 frames per second. In another view, if the real time streaming rate is 1.2 megabits per second on a dedicated, high bandwidth connection, the streaming rate on the Internet to a subscriber for the slow-motion clip will be 240 kilobits per second.

In Fig. 2A window 210 provides a default text for an authored clip, and check box 212, if checked, causes a selected clip to begin to stream to the server as soon as a start point is marked. If this box is left unchecked the streaming will not occur until the end of the clip is selected.

Area 215 is an area for display of first frames of scenes as detected by scene-detection software, from which an author may select for storing as slow-motion clips to be available for subscribers.

Fig. 2B is another view of the authoring interface of Fig. 2A, showing a floating window 213 for the author to enter an alternative text annotation, which will be replace the default text annotation of window 210 of Fig. 2A. If a video clip selected and stored for slow-motion replay to subscribers is a pass from Terry to Wright, for example, the annotation may be as simple as that shown in window 213.

Fig. 3 illustrates an exemplary interactive display at a user's premise (Fig. 1, element 23) before a replay window opens. Region 301 in this display is a window for playing the primary video, and region 303 is a region reserved for replay video. Region 305 is for display of interactive text annotations as described above. One such annotation "Terry to Wright" is displayed in this region in Fig. 3. As previously described the text annotations are pushed to subscribers as slow-motion replays become available, and are displayed as hyperlinks, such that selection (by clicking for example) by a viewer sends a signal to the provider server (links 43 and 41 Fig. 1) requesting replay for the represented clip.

Once the backlink signal for "Terry to Wright" is received at server 39, software at server 39 causes the clip to be retrieved from memory and streamed to the requesting subscriber. This streaming over the Internet in this case is at .2 of the real-time rate, as described above. The slow-speed streaming for the video clip provides a playable stream at the user's premise at a slow motion rate 1/6 of real-time action (assuming real-time is represented by 1.2 megabits/sec.). Moreover there is little if any loss of data, because the slower rate is well within the effective streaming rate for the Internet. The slow-motion clip the requester receives then, at 5 frames per second (assuming real time rate is 30 frames/sec), has high quality frame data with little loss.

Fig. 4 shows the user interface screen of Fig. 3 with a replay window open playing a slow-motion replay while a main video continues to play in a separate window. After a subscriber selects a text annotation in region 305 (Fig. 3), the provider server 39 begins to stream the requested clip, and window 401 opens and plays the slow motion clip.

In a simple embodiment the clip is played as received and not stored, and therefore may be seen from beginning to end each time the clip is requested. In a more sophisticated embodiment the clip is stored at the user end, and may therefore be stopped, rewound, replayed, and so forth. A set of control buttons as shown just below the replay window 401 are for this purpose. In another embodiment wherein the clip is stored, the clip may be recalled, and replayed at adjusted speeds, including slower, and at speeds up to and beyond the real-time rate. The quality at all other adjusted speeds

will be better than for any video streamed on the Internet originally at a much faster rate, because the individual frames streamed at the slower rate will have significantly lower loss. Region 403 in Fig. 4 continues to play the primary video stream, and a control 405 is provided for the viewer to revert to just the primary video.

In yet another embodiment of the invention facility is provided at the user's equipment for frame capture, wherein a user may stop replay of a clip, and grab and store and/or print a frame converted from the video data to a graphics format such as .jpg of .gif.

It will be apparent to one with skill in the art that a variety of connections and entities may be substituted for those illustrated in the example without departing from the spirit and scope of the present invention. For example, Internet network 17 (Fig. 1) may be a private wide area network (WAN) instead. Cable network 13 may instead be a satellite network. There may be more than one editing station or broadcast studio in line from the video source (11) to the end viewer at premise 23. There are many variant possibilities. The inventor intends that system 9 be exemplary of only one example of many possible architectures.

In some embodiments of the invention the connection between the server and the client will be a relatively high-bandwidth connection, and in some embodiments that connection may be a relatively low-bandwidth connection. accordingly, the way in which replay video clips are streamed may differ somewhat. Provision is made in some embodiments, where the connection is a relatively high bandwidth connection, to send only text annotation to the client immediately, which the client may use to select the clips to be downloaded. In the case of relatively low bandwidth connections, in other embodiments, the clips are all streamed to the client and stored locally at the clients premises for later selection and viewing.

Fig. 5A is a process flow chart illustrating logical steps for creating, delivering, and viewing authored slow-motion video sequences according to an embodiment of the present invention wherein the client-to-server connection is relatively high bandwidth. To initiate the process, a viewer orders a video in step 69. An order of a video such as a service-covered pay-per-view video sends notification to software 38 to activate the

viewer's Internet connection if not already activated. If a viewer simply turns to a standard channel showing a service-covered live event, or switches to a special channel dedicated to presenting live events, then a means for initiating Internet connection and notifying service providers of the viewers status is similarly activated.

In step 71, the primary video, which may be a live sports event, (feed) is received and prepared for broadcast/multicast to viewers such as at premise 23 of Fig. 1. In step 73 a viewer receives the video from a studio such as studio 15 of Fig. 1 and begins viewing the edited video. Within an acceptable time frame, the primary stream feed is also delivered, in step 75, to an authoring station such as station 19 of Fig. 1. Step 75 may in some embodiments, occur ahead of step 73 if an un-edited version is relayed to an authoring station. This may allow more of a pipeline for editing purposes as previously described.

In step 77, an author selects and creates video clips and associated text indicators as described above, often with the aid of software and hardware tools. In step 79, created clips are stored in an on-line server such as server 39 of Fig. 1 while the associated text indicators are pushed to viewers over their Internet connections in step 81. In step 83, text indicators begin appearing in the viewer's display. As each indicator appears, it represents an available video clip that is ready to be streamed.

In step 85, a user decides to initiate a request by selecting and activating a text indicator, which represents an available clip. This action sends a backlink command over the Internet to a server 39 to commence streaming the requested video clip back over the same Internet path in step 89. In step 89, a viewer begins receiving a slow motion video clip at a rate of approximately 200 Kbps, which immediately appears on a suitable display as a slow motion replay of an event that has occurred in the main video. At step 91 a user receives the clip.

Fig. 5B is a process flow diagram illustrating operation in an embodiment having a low-bandwidth connection between the server and a client. In this embodiment block 68 represents the video feed, and at step 70 the video feed goes to the authoring station. At step 72 the author creates Replay clips and sends Replay information, i.e. Replay media file url, filetype, annotation, timestamp, etc., as XML

data. At step 74 text indicators and video clips are sent to the server. At step 76 the Text indicators for a new Replay are delivered and stored in a user's local cache area. At step 78 the new Replay clip is downloaded into the replay storage location on the user's local hard disk or other mass storage device. At step 80 the text indicators are displayed for a user to select associated clips. At step 82 the user selects one of the text indicators and thereby selects a Replay clip. Finally at step 84 the Replay clip is played from the user's storage area.

The process steps represented and described herein are intended to be construed as exemplary only for a simple embodiments of the invention. As described above there may be further steps in practicing the invention, such as replaying at adjusted rates, as well as frame capture and conversion. Depending on system architecture and number of participating entities, steps may be varied in specific order and perhaps have varied function.

Fig. 6 is a block diagram of a hardware architecture in more detail than the diagram of Fig. 1, illustrating an architecture according to an embodiment of the present invention. The architecture in this example is divided into three logical groups as Authoring Side 93, Head End 95 and Client (user) end 97, which may be generally equated to elements 19, 15 and 23 of Fig. 1.

In Authoring Side 93 a video source 99 is provides a video stream, and the source may be of any conventional sort, such as a live video cam, a VCR, or some other source, such as a digital file stored on a server by a content provider. Video from the source, typically digitized at 30 frames per second (FPS) at an encoding bit rate of 800 to 1200 kbps, goes to MPEG encoder 101 and to a Microsoft Advanced Streaming Format (ASF)^{TM} encoder 103. The ASF encoder is an example of one of several encoders that might be used to encode the main video stream.

A replay-authoring console 105 on the Authoring side receives the MPEG stream from MPEG encoder 101, and executes software for authoring functions as described above. The author at the console can make the selections for video selections (clips) to be replayed by clicking on scene thumbnails in the Replay authoring console display, as also described above.

The replay stream from the replay authoring console goes in some embodiments to MPEG Astra Transfer Protocol (ASTP) server 107 in head end 95. The ASTP is an example, and there are other protocols that might be used. This streaming is at a controlled rate. The rate depends on the available bandwidth between the authoring station and the MPEG server at the Head end. With a dedicated T1 link the rate can be 1.544 Mbps. A control information is sent saying that replay is ready to be streamed from the Authoring server to an Astra Control Distribution (ACSD)server 113 (in this example) at the Head End.

The main video stream from ASF encoder 103 at the Authoring side goes to Netshow server 109 at Head End 95. In addition to the above there may be additional authoring, for which a parallel stream may go the an independent authoring station, and the authored stream then goes to the ACSD server 113 at the Head End.

Fig. 6 shows two situations, one in which there is a relatively high bandwidth connection to the user's premise, such as may be the case with a set top box receiving cable TV. The high bandwidth premise is represented by element number 115. There is provision in the software at the high-bandwidth premise for displaying the main video and selected replays, as described above. These separate displays are indicated by elements 117 and 119. Netshow server 109 at the Head End streams the main video to main video display 117. Whenever a user selects to see a replay clip the Theatre client connects to the MPEG video server at the Head End, which then streams high bit-rate-encoded video at a low bit rate of 150 to 400 kbps. The Theatre client will now show the video clip at low effective frame rate to the end user. The video, which at real-time rate lasts for 1 min (for example), is now displayed for a longer time, such as 2 min for 0.5 rate to 5 min. for 0.2 rate.

In some cases there will be a low bandwidth connection to the user premise., and the low-bandwidth user premise is represented in Fig. 6 by element number 123. The low-bandwidth premise includes a local memory cache 125. ASTP server 107 in this case streams both replay clips and associated text to local cache 125. There may also be a Web server 121 receiving replay data from authoring console 105 and providing the data to cache 125. Text for selection is played from the cache, and upon

selection, clips are played (127) from the user's mass storage device, such as a hard disk. In the case of the low bandwidth connection it is necessary to send the clips on ahead rather than storing them for real-time download at the server end.

In the low-bandwidth premise as represented in Fig. 6 the bandwidth is too low for effective display of the main video stream, so the main video is not displayed. In certain cases the main video can be displayed but it will be of low quality and encoded at bit-rates of 28.8 or 56 Kbps. This will result in delay in downloading of replay video. The user in this case, since the replay clips are played from the local cache area, has full control over the playback speed. The replay clips can be downloaded through vertical blanking interval (VBI) or MPEG-2 transport stream if the equipment offers local storage capability, and the clips can be eventually played from there.

It will be apparent to one with skill in the art that the method and apparatus of the present invention may be practiced in varying embodiments having different system architecture without departing from the spirit and scope of the present invention. For example, a viewer may have a wireless connection to the Internet while viewing a presentation over cable. The authoring and delivery of video may be practiced in conjunction with a private WAN instead of the public Internet. There are many possibilities. Therefore, the method and apparatus of the present invention should be afforded the broadest scope. The spirit and scope of the present invention is limited only by the claims that follow.

What is claimed is:

1. A slow-motion video replay system, comprising:

a software-enabled, Internet-connected server storing video clips of action scenes selected from a primary video presentation; and

an Internet-connected client computerized viewer station having a video display unit (VDU) and an interactive user interface;

wherein the server provides displayable indicia uniquely representing individual video clips stored at the server to the client as displayable hyperlinks, and in response to the client selecting one of the displayable indicia, streams the associated video clip to the client at a rate less than the real-time video rate, such that the video clip displayed at the client's station plays at a slow-motion rate.

2. The system of claim 1 wherein the video clip streaming rate is equal to or less than one-half the real-time rate.

3. The system of claim 1 wherein the video clip streaming rate is equal to or less than one-fourth the real-time rate.

4. The system of claim 1 further comprising an authoring station coupled to the server and a service provider streaming the real-time primary video presentation to the client for display and also to the authoring station.

5. The system of claim 4 wherein the authoring station enables an author to create, select, and store video clips at the server, including associating the displayable indicia with the video clips.

6. The system of claim 5 wherein the displayable indicia comprise text strings describing the associated video clip.

7. The system of claim 4 wherein the client station is enabled to store streamed slow-motion video clips, and the user is enabled through the interactive interface at the client station to retrieve and replay the stored clips, including adjusting the play rate from the streamed and stored rate.

8. The system of claim 7 wherein the user is enabled to grab a selected frame from a video clip and to convert the frame to a standard still graphics format, including one or both of .gif and .jpg.

9. A video authoring and server system comprising:

an authoring station including software enabling tools for an author to monitor a video presentation, to select video clips from the presentation for storage, and to prepare and associate an displayable indicia identifier with each video clip; and

an Internet-connected server including software enabling pushing of the identifiers for video clips to clients as hyperlinks, and streaming of video clips to clients in response to signals from clients resulting from selecting the hyperlinks, the video clips streamed to clients on the Internet at a rate less than the real-time video rate.

10. The system of claim 9 wherein the video clip streaming rate is equal to or less than one-half the real-time rate.

11. The system of claim 9 wherein the video clip streaming rate is equal to or less than one-fourth the real-time rate.

12. The system of claim 9 wherein the displayable indicia comprise text strings describing the associated video clip.

13. A client system for video display comprising:

a computerized video display apparatus;

a high-bandwidth dedicated port for receiving a primary video stream; and

an Internet port for requesting and receiving video clips of sequences selected from the primary video stream;

wherein the video display system displays a primary video stream received on the dedicated high-bandwidth port and interactive hyperlinks uniquely associated with individual ones of the video clips, the hyperlinks received on the Internet port, and wherein upon selection of a hyperlink the apparatus receives on the Internet port a secondary data stream for the video clip associated with the hyperlink, the secondary data stream received and displayed at a rate less than the real-time rate.

14. The system of claim 13 wherein the video clip streaming rate is equal to or less than one-half the real-time rate.

15. The system of claim 13 wherein the video clip streaming rate is equal to or less than one-fourth the real-time rate.

16. The system of claim 13 wherein the hyperlinks comprise text strings describing the associated video clip.

17. The system of claim 13 wherein the computerized apparatus is enabled to store streamed slow-motion video clips, and the user is enabled to retrieve and replay the stored clips, including adjusting the play rate from the streamed and stored rate.

18. The system of claim 17 wherein the user is enabled to grab a selected frame from a video clip and to convert the frame to a standard still graphics format, including one or both of .gif and .jpg.

19. A method for providing video clips over an Internet connection with high frame quality, comprising steps of:

(a) receiving a request for a stored clip at an Internet-connected server; and

(b) streaming the stored clip to the requester at a rate less than the real-time rate.

20. The method of claim 19 wherein the clip streaming rate is equal to or less than one-half the real-time rate.

21. The method of claim 19 wherein the video clip streaming rate is equal to or less than one-fourth the real-time rate.

22. The method of claim 19 further comprising a step for designating at an authoring station coupled to the server, the authoring station monitoring a primary video stream, sequences from the primary video stream as clips, and associating a unique identifier with each clip.

23. The method of claim 22 wherein the identifiers comprise displayable indicia pushed to clients on the Internet as hyperlinks associated with stored clips.

24. The method of claim 23 wherein the hyperlinks are text strings describing the associated video clips.

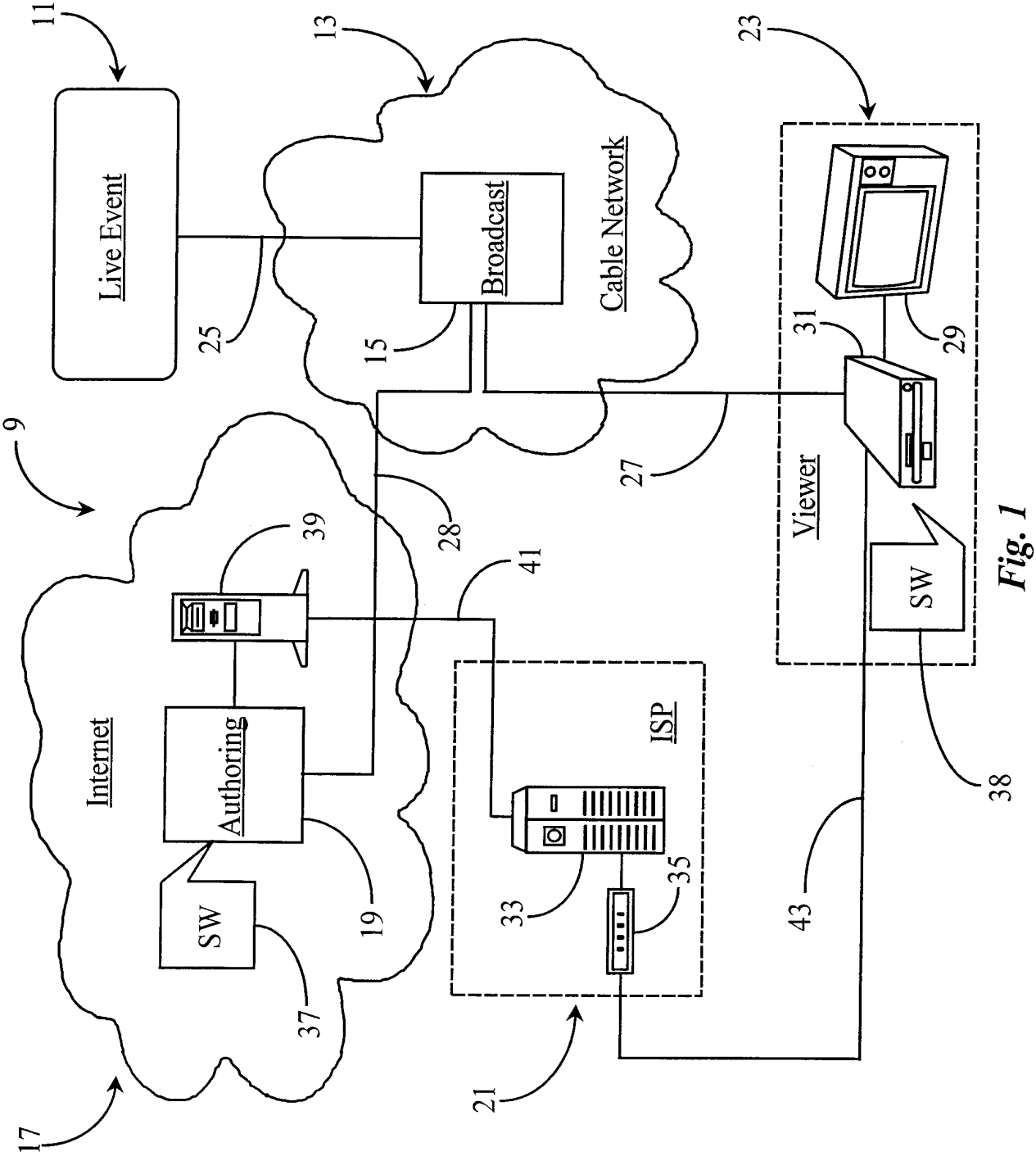

11
Live Event
25
13
Broadcast
15
Cable Network
23
31
29
Viewer
SW
38
27
28
9
39
41
Internet
Authoring
SW
37
19
ISP
33
35
43
21
17

Fig. 1

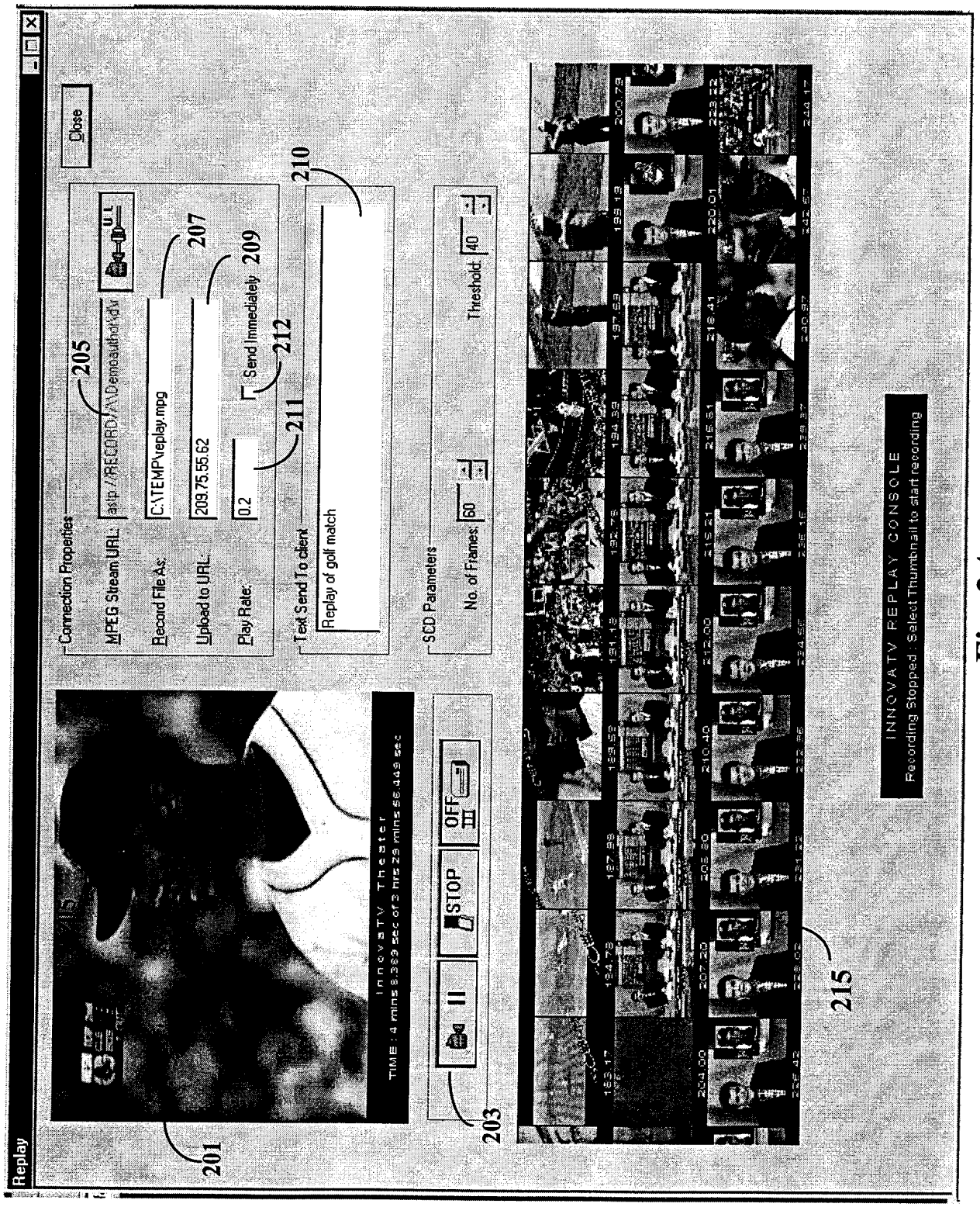

Replay
Connection Properties
MPEG Stream URL:
http://RECORD/AVDemoauthor.dvr
Record File As:
C:\TEMP\replay.mpg
Upload to URL:
209.75.55.62
Play Rate:
0.2
Send Immediately
Text Send To client
Replay of golf match
SCD Parameters
No. of Frames:
60
Threshold
40
Close
STOP
OFF
INNOVATV REPLAY CONSOLE
Recording Stopped : Select Thumbnail to start recording
201
203
205
207
209
210
211
212
215

Fig. 2A

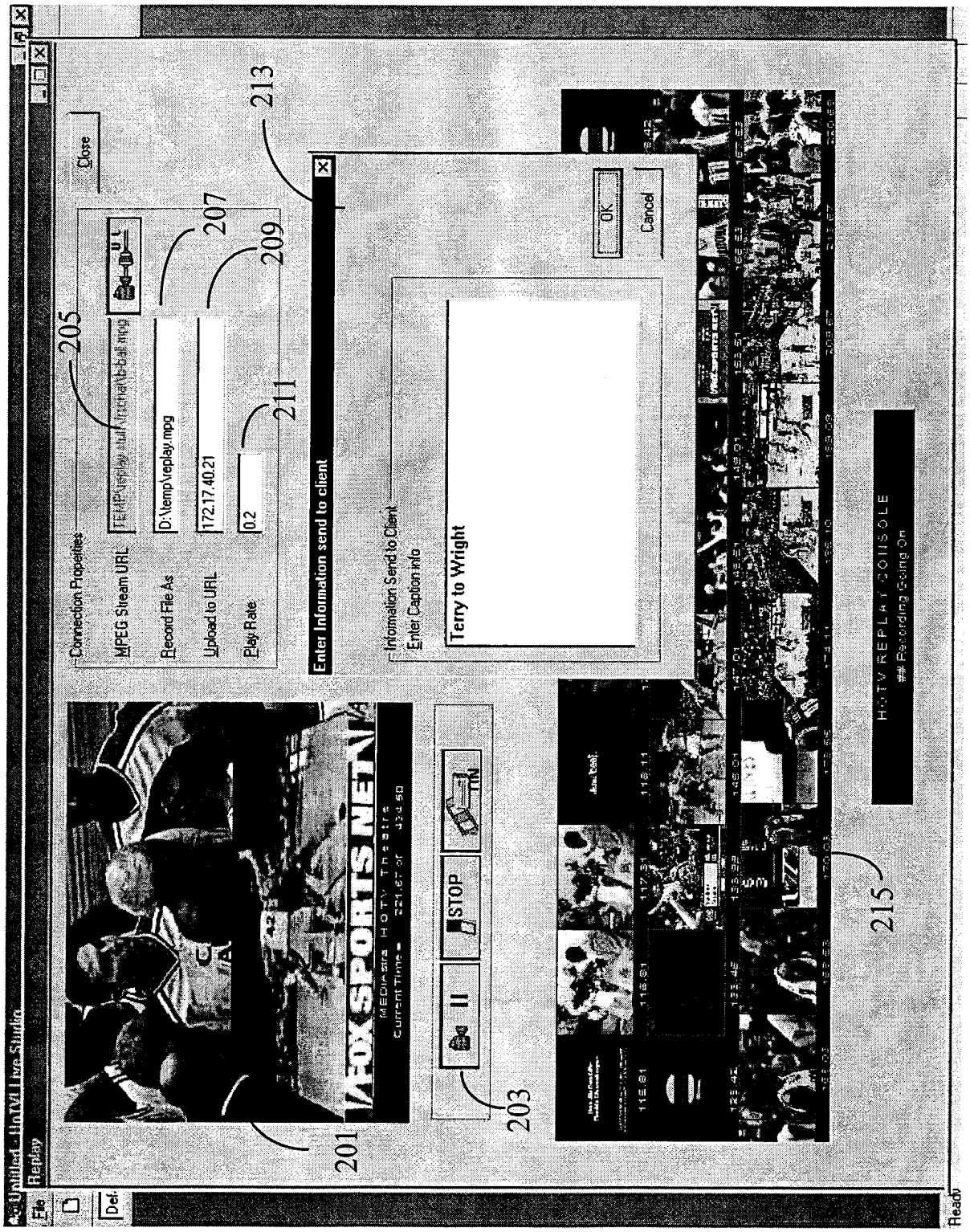

Replay
Close
Connection Properties
MPEG Stream URL
Record File As
Upload to URL
Play Rate
D:\temp\replay.mpg
172.17.40.21
0.2
205
207
209
211
213
Enter Information send to client
Information Send to Client
Enter Caption info
Terry to Wright
OK
Cancel
STOP
201
203
215
HDTV REPLAY CONSOLE
Recording Going On
Ready

Fig. 2B

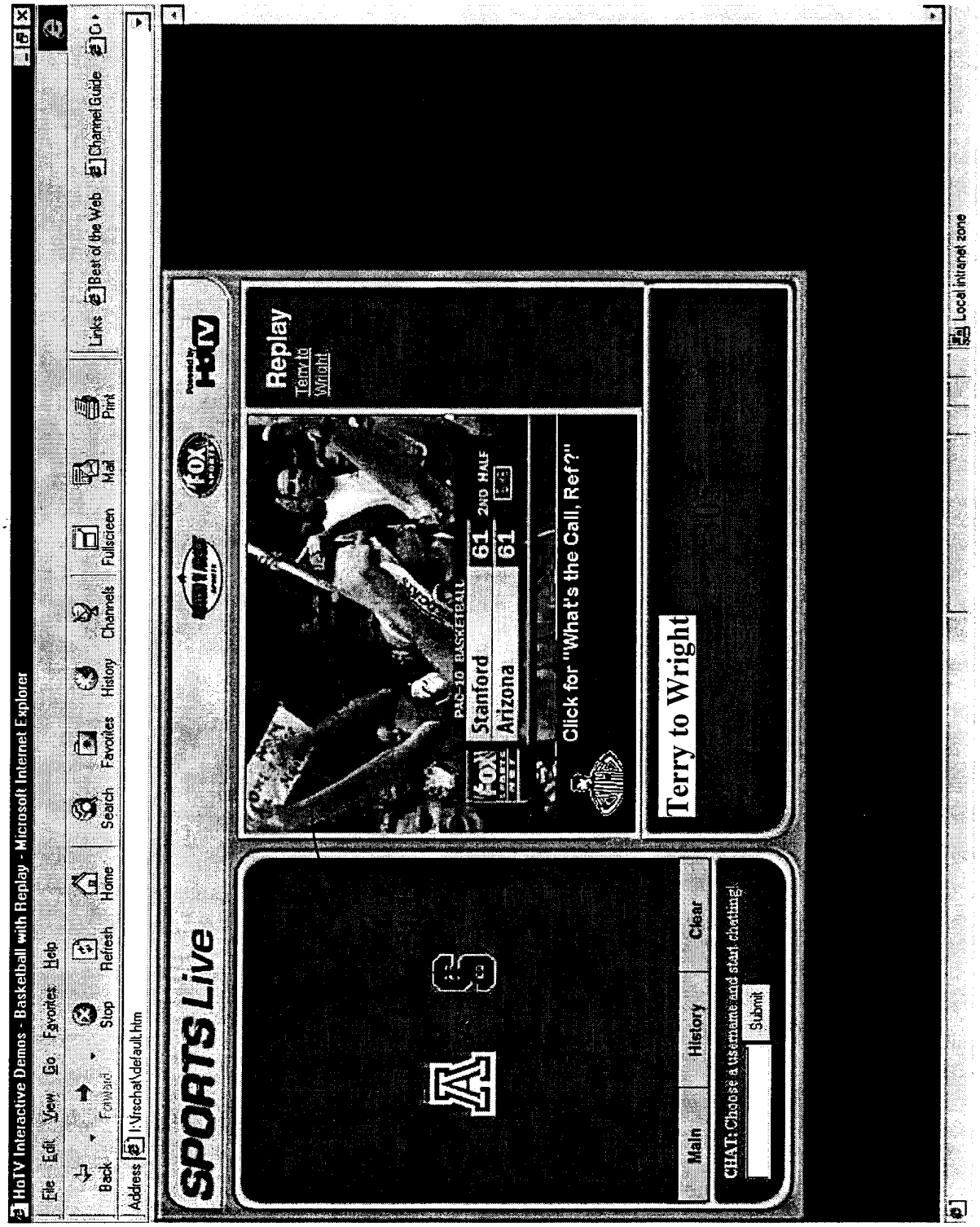

HoTV Interactive Demos - Basketball with Replay - Microsoft Internet Explorer
File Edit View Go Favorites Help
Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print Channel Guide
Address I:\Vschat\default.htm
SPORTS Live
Powered by HoTV
Replay
Terry to Wright
PAC-10 BASKETBALL
Stanford 61
Arizona 61
2ND HALF
Click for "What's the Call, Ref?"
Terry to Wright
Main
History
Clear
CHAT: Choose a username and start chatting!
Submit
Local intranet zone

Fig. 3

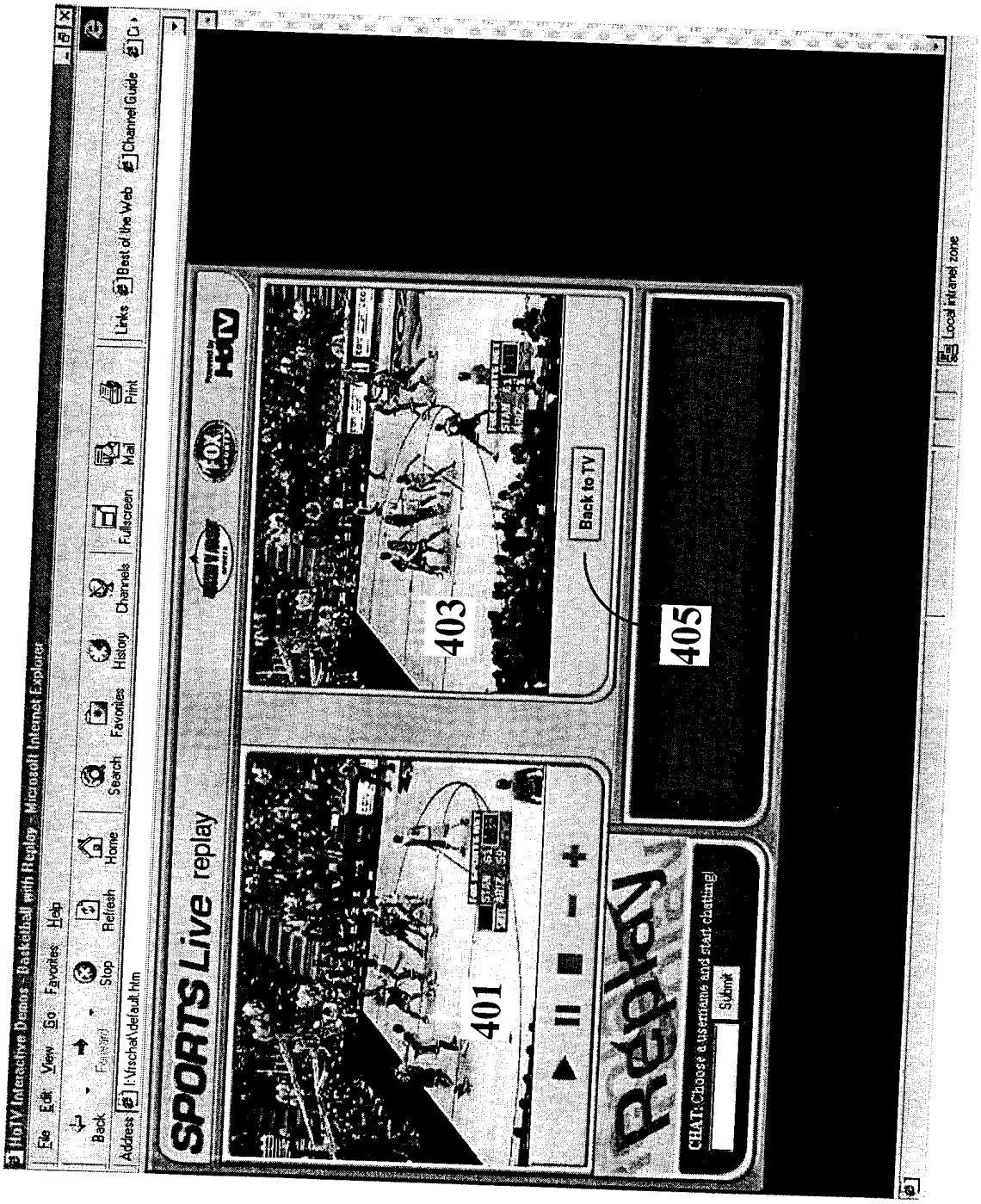

HDTV Interactive Demos - Basketball with Replay - Microsoft Internet Explorer
File Edit View Go Favorites Help
Back Forward Stop Refresh Home Search Favorites History Channels Fullscreen Mail Print
Links Best of the Web Channel Guide
Address I:\Vrschat\default.htm
SPORTS Live replay
Powered by HDTV
FOX SPORTS
401
403
405
Back to TV
CHAT: Choose a username and start chatting!
Submit
Local intranet zone

Fig. 4

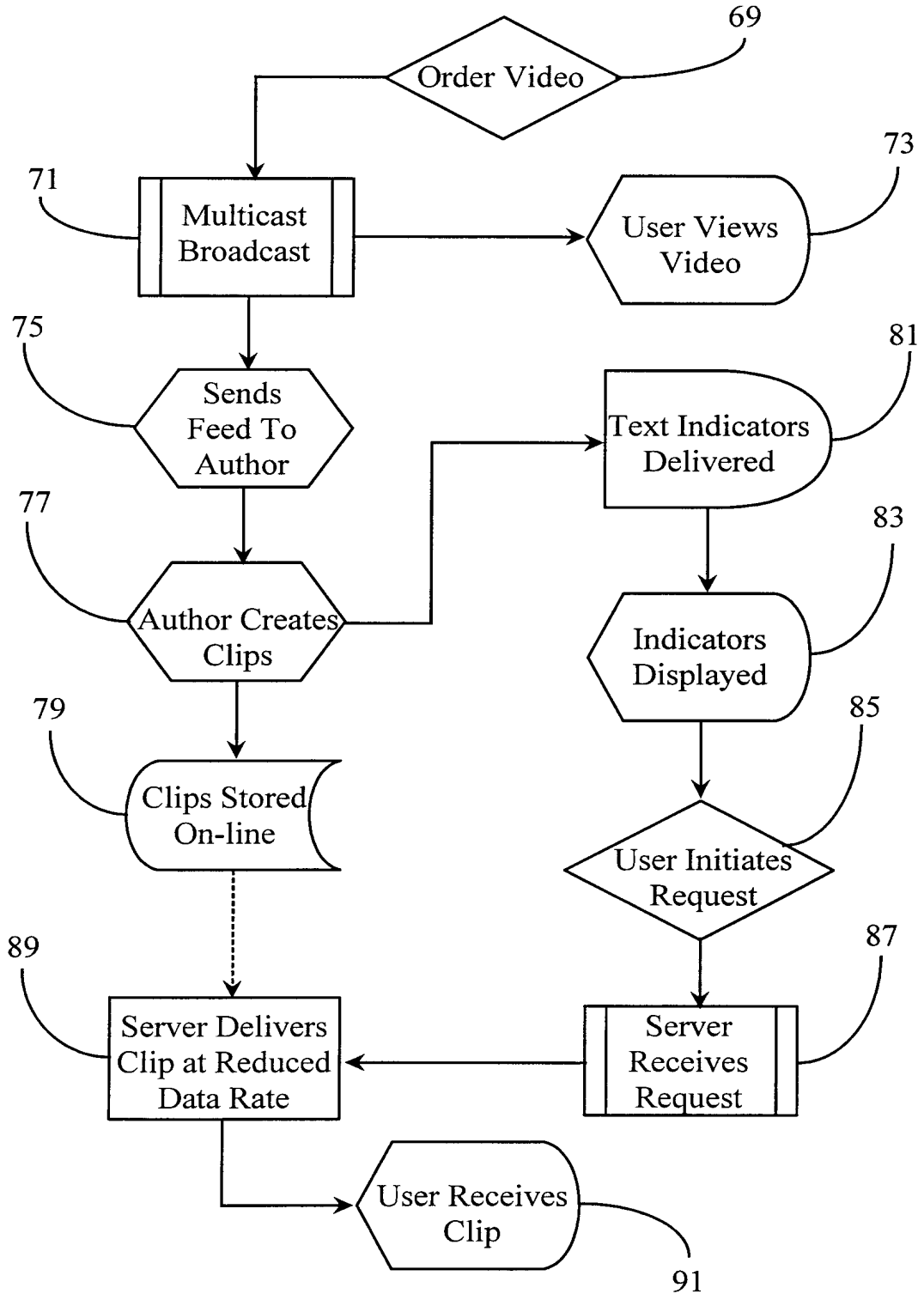

69
Order Video
71
Multicast Broadcast
73
User Views Video
75
Sends Feed To Author
81
Text Indicators Delivered
77
Author Creates Clips
83
Indicators Displayed
79
Clips Stored On-line
85
User Initiates Request
89
Server Delivers Clip at Reduced Data Rate
87
Server Receives Request
User Receives Clip
91

Fig. 5A

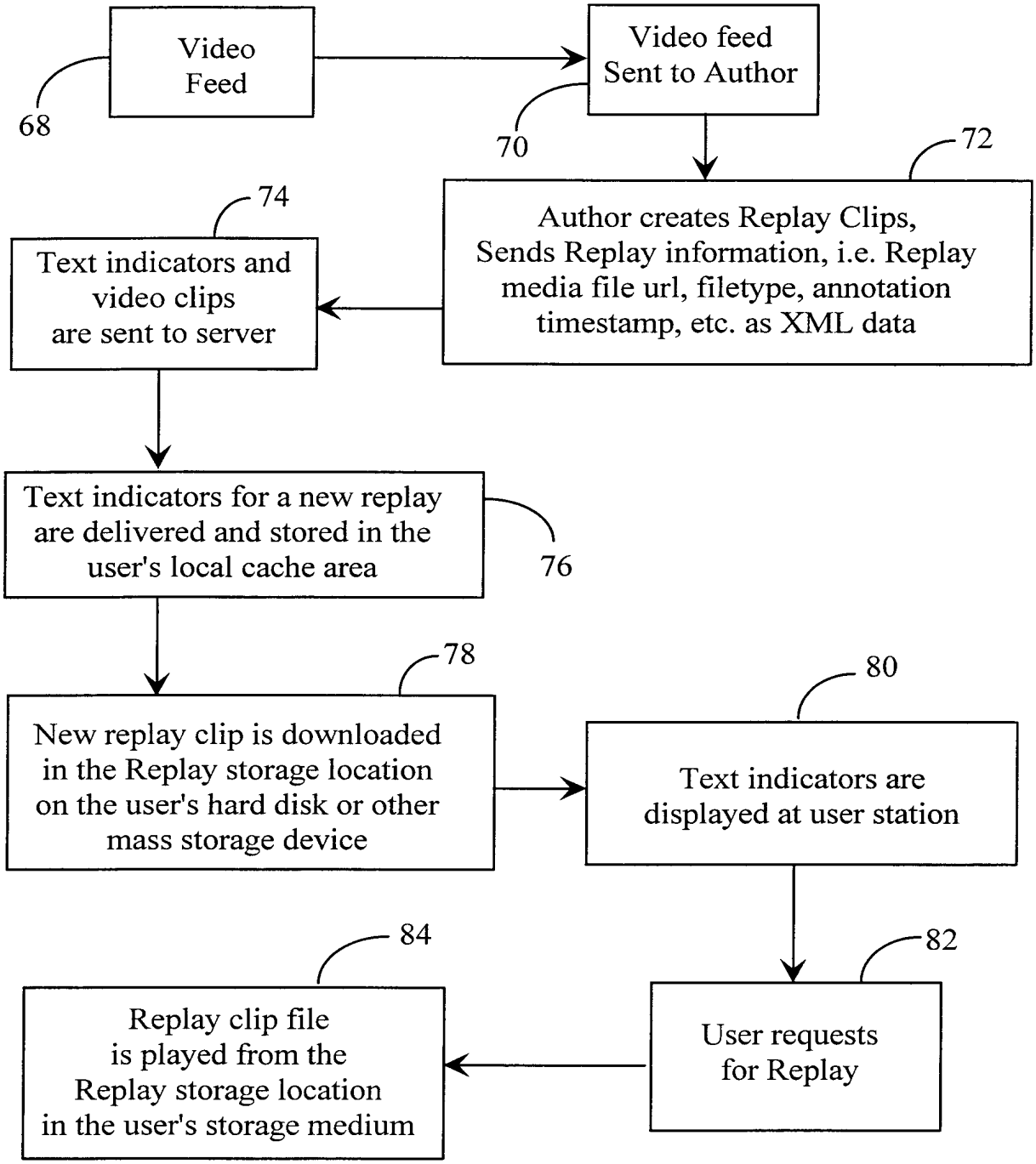

Video Feed
68
Video feed Sent to Author
70
72
Author creates Replay Clips, Sends Replay information, i.e. Replay media file url, filetype, annotation timestamp, etc. as XML data
74
Text indicators and video clips are sent to server
Text indicators for a new replay are delivered and stored in the user's local cache area
76
78
New replay clip is downloaded in the Replay storage location on the user's hard disk or other mass storage device
80
Text indicators are displayed at user station
82
User requests for Replay
84
Replay clip file is played from the Replay storage location in the user's storage medium

Fig. 5B

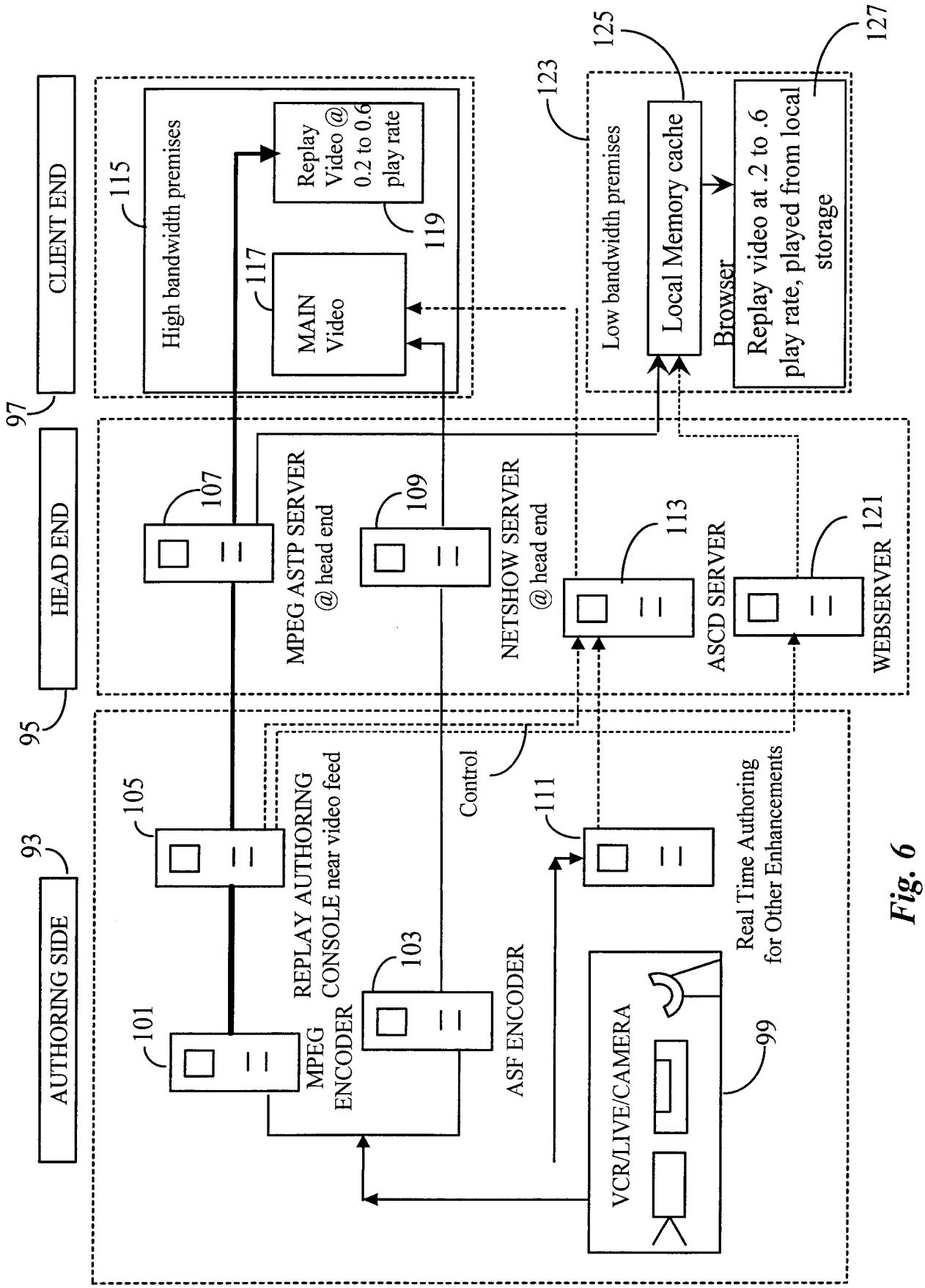

CLIENT END
97
HEAD END
95
AUTHORING SIDE
93
High bandwidth premises
115
Replay Video @ 0.2 to 0.6 play rate
119
MAIN Video
117
Low bandwidth premises
123
Local Memory cache
125
Browser
Replay video at .2 to .6 play rate, played from local storage
127
MPEG ASTP SERVER @ head end
107
NETSHOW SERVER @ head end
109
ASCD SERVER
113
WEBSERVER
121
Control
REPLAY AUTHORING CONSOLE near video feed
105
MPEG ENCODER
101
ASF ENCODER
103
111
VCR/LIVE/CAMERA
99
Real Time Authoring for Other Enhancements

Fig. 6